

## **The U.S. Department of Energy small modular biopower initiative**

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In 1998 the U.S. Department of Energy began a multi-phase Small Modular Biopower Initiative for developing biomass-based electricity generating systems less than 5 megawatts. Phase 1 was a feasibility study that included an integrated business and technical development plan. The Phase 2 objectives are to demonstrate the operation of a prototype small scale-biopower system, complete a detailed business plan (including feedstock resource assessment), and establish a strategic partnership with a distribution/service entity. The Phase 3 objective is to develop and demonstrate an integrated small-scale biopower system with the operation and performance required to successfully compete in the target market. This paper provides an overview and status of the initiative.

Small modular biopower (SMB) systems can help supply electric power to more than 2.5 billion people who currently live without it, especially to those in areas where large amounts of biomass are available for fuel. Small systems could provide power at the village level to serve many of these people. Small biomass systems also have a great potential market in industrialized regions for distributed applications. Both applications have large potential markets inside the United States and abroad. Biomass provides an alternative to small fossil fuel-powered systems that is more environmentally acceptable.

The U.S. Department of Energy (DOE) Small Modular Biopower Initiative is working with industry to develop small biopower systems that are efficient and clean. Projects consist of feasibility studies, prototype demonstrations, and ultimately full system integration based on a business strategy for commercialization.

In 1998, the National Renewable Energy Laboratory (NREL) and Sandia National Laboratories placed ten contracts to determine the feasibility of developing cost-effective technologies and identifying the potential markets for each of the systems. Each participating company shared at least 20% of the cost. The studies addressed the following technical issues: 1) system capacity, 2) load following ability, 3) system fuel consumption, 4) fuel flexibility, 5) number of operators and required training, 6) life cycle costs, 7) environmental impacts, 8) safety, 9) load profile, 10) fuel, 11) fuel handling/feeding system, 12) system transportability, 13) maintenance schedule and costs, 14) water consumption, and 15) capability for remote monitoring. Extended executive summaries for the studies are available at <http://www.eren.doe.gov/smallmod.html>, and include performer contact information.

We continued the Initiative in 1999 by issuing a Phase 2 solicitation for prototype systems. The Request for Proposals was issued in April 1999; the solicitation closed in July 1999; and initial awards were made in September 1999. Projects were solicited that were 18–24 months in duration, that included 50% in-federal cost share, and that involved as much as 3 million USD federal cost share over the duration of the project.

Four projects have been awarded as part of Phase 2 of the Initiative. Awards have been made to CPC for developing village power energy systems based on downdraft gasification/ICE technology, to External Power for developing residential power systems based on combustion/Stirling engine technology, to Carbona Corporation to develop a gasification/steam turbine system, and to Flex Energies for developing distributed power generation systems using a microturbine to generate electricity from various biogases.

**Community Power Corporation**

The basic SMB design uses a fixed-bed downdraft gasifier feeding producer gas to an SI engine coupled to a generator. This design includes operation such that no liquid effluent will be produced from the system. The gasifier design also incorporates features that promise to produce a low tar and ash gas stream that will be filtered. Field surveys in the Philippines, conducted by CPC, have identified capacity requirements for these types for systems in the range of 12 kW to 25 kW. The first unit was shipped to the Philippines in February 2001. A second unit will be installed at the Hoopa Indian Reservation in California in the summer of 2001. Shell International Renewables, the California Energy Commission, and the Hoopa Indian Tribe are strategic and funding partners.

**External Power, LLC**

External Power is developing an SMB system that employs a Stirling engine as the prime mover. Heat to drive the Stirling engine is extracted from the combustion gases of a modified pellet stove. This design also recovers significant amounts of heat from the exhaust gases after the Stirling engine and transfers it to the incoming combustion gases to improve the overall combustion efficiencies. Development of very clean biomass burners is another part of this effort. This system is being designed for 1–2 kW output and targeted at residential markets. External Power is focusing on markets in northern Europe and the Scandinavian countries for initial entry of their SMB. Energidalen is a well recognized biomass research center in Solleftea Sweden and has agreed to be a strategic partner with External Power to help provide credibility for these systems for penetration of the European markets. Wood Mizer and SunPower are strategic and funding partners.

**FlexEnergy, Inc.**

Flex Energies, Inc. is designing and fabricate a proof of concept (POC) 30-kW Flex-Microturbine™ unit for evaluation purposes. A unique design that will permit the use of very low heating value gases—3.7 kJ/Nm<sup>3</sup>. Following successful completion of a POC test program, the design will be modified and three prototype units will be constructed. Prototypes will be tested using landfill gas, anaerobic digester gas, and gasification producer gas. Capstone Turbine Corporation, California Energy Commission, University California Davis, and Cal Poly Obispo are partners in the project.

**Carbona Corporation**

Carbona Corporation will design, fabricate and operate a prototype CHP system based on an updraft gasifier. The plant will consist of 5 shop fabricated modules—gasifier, boiler, steam turbine generator, balance of plant and electrical system. The system will be located at the Galten Commune in Jutland, Denmark and will replace a conventional wood burning boiler. The capacity of the prototype plant will be about 2.3 MW electricity and 7MJ/s district heat and will fueled primarily by wood chips. Strategic and funding partners are FLS miljø, the Danish Energy Agency, and the Galten Commune.